



## Potential Economic Loss Associated with Gypsy Moth on Trees in Iowa

### Background

Gypsy Moth is a European insect species introduced in Boston, MA in 1869 as an experiment to help provide silk for the textile industry. This exotic insect continues to spread west from that introduction site and defoliate native forests wherever it becomes established and has become the most important defoliating insect of hardwood trees in the Eastern U.S.

Establishment of gypsy moth in Iowa will affect the survival of both the mature and oldest trees the most. The larvae of this insect will feed on the leaves of over 300 host species during the summer removing a tree's ability to create food with its leaves. It is repeated defoliation that occurs several years in a row on the same trees that will deplete the stored reservoirs of nutrients the tree has, thus leading to the decline of that tree.



Gypsy moth caterpillar- notice the blue and red colors along the back

The 2012 gypsy moth survey conducted by Iowa Department of Natural Resources (IDNR) foresters, Iowa Department of Agriculture and Land Stewardship (IDALS), and U.S.D.A Animal Plant and Health Inspection Service (APHIS) have found male gypsy moths present in Iowa. The survey which has been occurring in Iowa since 1972 collected 225 male gypsy moth in 2012; down from a record 2,260 male gypsy moths in 2010. The 2012 captures are down as a result of the 2011 mating disruption treatment.

The concern of having gypsy moth moving into Iowa, is the potential loss of economically critical and ecologically dominant oak species (*Quercus*, spp.). The oak-hickory forest type is 26% of Iowa's total tree cover. And about 27 million trees (15%) of that forest are over 80 years old.<sup>1</sup> Most studies of forest compositional changes associated with gypsy moth defoliation indicate that less susceptible species will replace oak trees.

Upon first arrival, extensive tree mortality is expected when gypsy moth larvae defoliate trees for two consecutive years. However, mortality can occur after one year of defoliation if other environmental stressors, like drought or tatters are present. Heavy defoliation increases the stress on those trees, which can make them more susceptible to other insect (two-lined chestnut borer) and disease (shoestring root rot) problems.

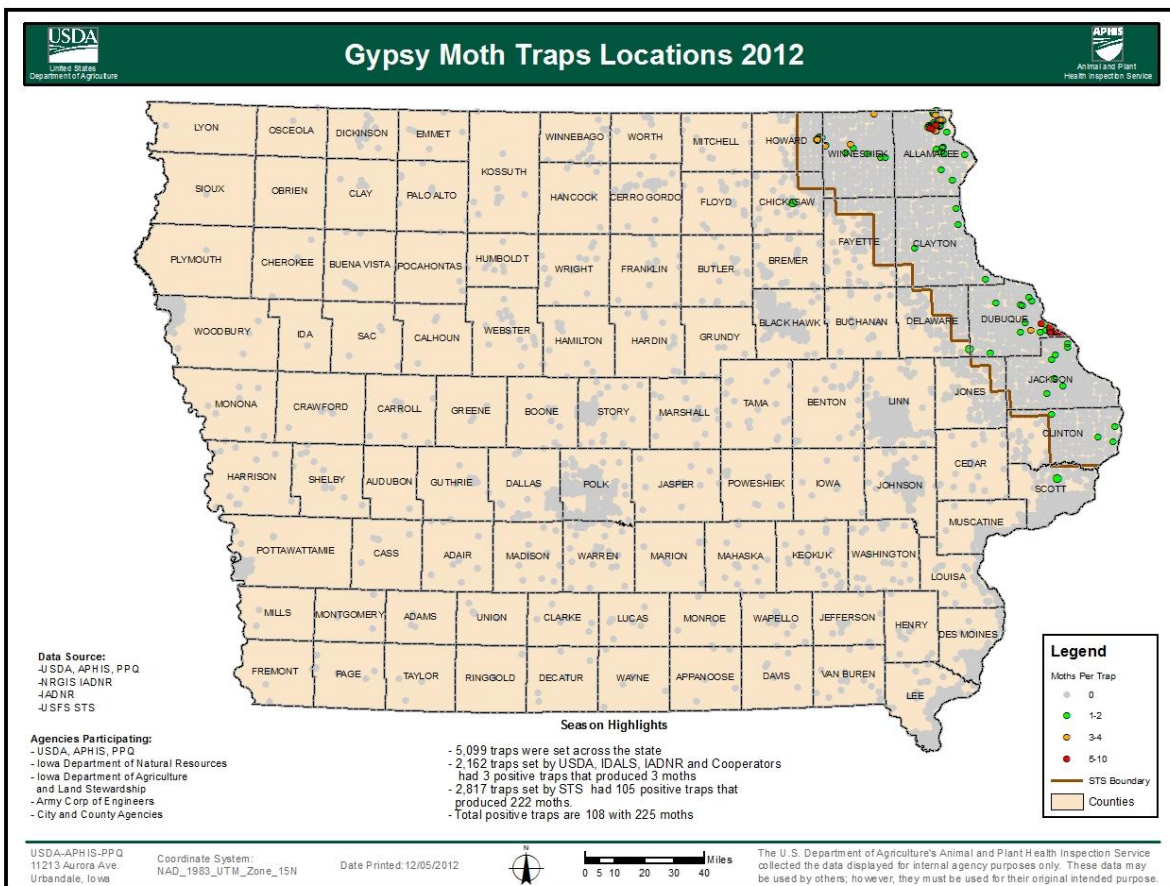
<sup>1</sup> Miles, P.D. Forest Inventory EVALIDator web-application version4.01 beta. St.Paul, MN:U.S. Department of Agriculture, Forest Service, Northern Research Station. December 13, 2012. <http://fiatools.fs.fed.us/Evalidator4/tmtribute.jsp>

Losing leaves early during the growing season, reduces the amount of growth those trees will be able to produce for that year, which results in lost income or delayed income to forest landowners, if timber is a product they are managing. If the trees are oaks, they will abort their acorns, resulting in less food for wildlife that eat acorns in the fall, along with less oak regeneration getting established. Forest ecosystems suffer from the loss of shade that the leaves would have offered as protection for birds and their offspring. More light reaches the forest floor which can help invasive plants grow and spread faster. Many native understory plants grow better under shady conditions.

Defoliation reduces the beauty that forests provide along scenic byways, state forests, state parks, and county parks in the area, which will diminish recreational experiences for both residents and visitors. Reduced camping within infested areas will reduce revenue for those parks along with increasing costs due to clean-up after the mess this insect makes.

When populations of gypsy moth caterpillars build up in trees and on houses, they produce a distinct noise from chewing the leaves and from fecal material dropping on patios, sidewalks, cars, roofs, and people, which is unpleasant for those experiencing this phenomenon. This fecal material increases uric acid, nitrates and coliform bacteria in lakes and streams where it gets washed into. Another effect caused by gypsy moth feeding is reduced property values and increased utility bills as trees are lost, usually the older more established majestic trees. Finally, some people are allergic to the hairs on gypsy moth egg masses, larvae and adult moths.

Based on survey for male gypsy moths in 2012, 10 counties in Iowa reported the presence of the insect. Within these counties there host tree species that are suitable for this insect to feed on. The map on the following page shows the distribution of gypsy moth in relation to the existing forest resource.



## Control

The decision to treat and control the gypsy moth populations is influenced by a number of factors including: the total number of male moths captured in traps, the number of visible gypsy moth egg masses, whether the area is adjacent to a heavily infested area, and whether the trees are defoliated or have dead and dying branches near the top of the tree where the caterpillars feed.

There are several insecticides that can be used as part of a suppression spray program. The safest are pheromone flakes, such as Disrupt II™, that disrupt the natural mating pattern by preventing the male moths from finding the female moths to breed. Mating disruption flakes “flood” the area with the scent of natural pheromone that the female moths produce, preventing the males from finding the female. Mating disruption can be effective at a low to medium level of infestation. The cost of mating disruption is \$8.00 per acre (6 grams used when moth captures exceed 10 moths per trap) or \$14 per acre (15 grams used when moth captures exceed 30 moths per trap).

Gypcheck™ is another commonly used viral insecticide that contains a virus that is specific to the gypsy moth caterpillars and can cause the populations to crash. Gypcheck™ is typically used in low level detections and can be used in conjunction with any other treatment option. Gypcheck™ cost about \$25 per acre treated.

A formulation of the bacterial insecticide *Bacillus thuringiensis kurstakii* (Btk) is only used when the gypsy moth populations are at a moderate to high level. Btk is the least toxic pesticide (after pheromone flakes and the viral insecticides), but it is not specific to gypsy moths and may cause other native caterpillar populations to crash. That is why Btk is used only when gypsy moths are at outbreak levels, and this insecticide can be used in limited areas to control gypsy moth population. When Btk is taken internally, the insect becomes paralyzed, stops feeding, and dies of starvation or disease. The cost of Btk is about \$25 per acre.

The control treatment options are all applied aerially to ensure that the pesticide lands on the tree canopy where it is effective. Ground-spraying is prohibitively expensive on a large area and are generally ineffective when the gypsy moth populations are on more than just a few trees.

The planes apply the control measures in late May and early June and fly roughly 50 feet above the canopy of the trees to ensure that the control method adheres to the foliage where it is effective. It takes about 30 minutes for the planes to treat a minimum of 600 acres.

The Gypsy Moth Slow the Spread Foundation, Inc. is a nonprofit organization that was established for the purpose of aiding in the implementation of the USDA National Slow the Spread Gypsy Moth Project, which is part of the USDA’s national strategy for gypsy moth management. By unifying partners and coordinating efforts among agencies, a well-coordinated action plan based on biological need using target treatment options has slowed the spread of

gypsy moth to an average rate of 3 miles per year. The benefit to cost ratio is more than 4:1, when looking at the impacts gypsy moth has on new areas.

Iowa has been part of the Slow the Spread Foundation since 2007. The foundation has provided funding to help place pheromone traps to capture male gypsy moths in the area. This trap data is used at a national level to determine the rate of spread of gypsy moth and to identify areas where control measures will need to be implemented. Due to the two concentrated pockets of moth captures in Iowa during the 2012 season, it is extremely likely that the foundation will financially assist Iowa in starting a mating disruption program in 2013. The foundation continues to assist states with trapping control implementation until the moth has fully established itself in part or all of the state. Once that happens, the cost of trapping and control is left to the State of Iowa.

### **Management Solution**

Proper woodland and community tree management have a critical role in creating healthy trees. The best insurance a landowner can have when managing their woodlands is to maintain a diversity of tree species; while ensuring an appropriate number of trees are growing on each acre. The best management plan for communities is to create diversity by not having more than 10% of any one species represented. These simple management plans provide the best defense against emerging forest health threats.

### **Wildlife Impacts**

Oak leaves are a preferred food source for gypsy moth caterpillars. As oak trees die from gypsy moth defoliation there will be less of this kind of habitat for the 200-300 wildlife species that depend on these trees for habitat and food, thus reducing opportunities to view or hunt for that wildlife in the future.

Acorns produced by oaks are eaten by many species of birds and mammals including deer, squirrels, mice, rabbits, foxes, raccoons, grackles, turkey, grouse, quail, blue jays, woodpeckers, and water-fowl.<sup>2</sup> The populations and health of wildlife often rise and fall with the availability of acorns in a forest. A reduction in the number of oak trees in Iowa's forests caused by gypsy moth defoliation will affect a wide variety of game and non-game species of wildlife.

<b>Primary Winter Food for Deer</b> (Order of Importance)
1.) Acorns
2.) Corn
3.) Coralberry
4.) Sumac
5.) Grass & Sedges

A primary fall and winter food for deer is acorns, composing around 54% of a deer's yearly diet. It has been estimated that in order to fulfill the needs of forest wildlife, 20 mast producing trees are necessary per acre. The number of trees per acre to produce an adequate supply of acorns for forest wildlife will depend on the population of forest wildlife, weather, the size, age and

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<sup>2</sup><[www.fnr.purdue.edu/inwood/past%20issues/HowtoManageOakForestsforAcornProduction.htm](http://www.fnr.purdue.edu/inwood/past%20issues/HowtoManageOakForestsforAcornProduction.htm)>. December 13, 2012.



health of those mast producing trees.<sup>3</sup> During years when not enough mast is produced by oak trees, more consumption of corn and other vegetation in the area is utilized.

In addition to being a source of food, oaks are currently a significant part of the largest forest type in Iowa. There are approximately 150,000 wild turkey and 400,000 deer that depend on forests for cover and search out oaks for mast before winter. Trees growing along river corridors, provide shade that decreases water temperatures in the streams below; sustaining fish populations that wouldn't otherwise exist. For example, native trout streams need a water temperature below 75 degrees for the trout to survive. A reduction in the oak-hickory forest type will negatively impact the economic contribution of \$1.5 billion that fish and wildlife recreation provides to Iowa's economy.



The picture above is an example of what will happen to forested areas across Iowa, as gypsy moth populations increase. Notice the brown areas that would have been green in this picture, if gypsy moth caterpillars hadn't eaten the leaves off of the trees in June.

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<sup>3</sup><<http://mdc.mo.gov/landwater-care/animal-management/deer-management/planning-ahead-wildlife-survival-white-tailed-deer>>. December 13, 2012.

## Economic Impacts

Using existing data from Forest Inventory and Analysis plots, Timber Products Output surveys, Timber Price Trend reports and the most recent street tree inventories, we can estimate the potential economic cost of gypsy moth in Iowa.

Since there are so many tree species that gypsy moth can feed on and defoliate, for analysis purposes only the tree species ranked with the highest suitability rating were considered. Bur oak was omitted because the economic impact has been calculated for it in regards to bur oak blight. We can estimate the economic impact of gypsy moth to the wood products industry in Iowa based on current harvesting rates for trees with the highest suitability rating to be impacted by gypsy moth.<sup>4</sup> The next table shows the economic impact harvesting the most suitable host trees for gypsy moth has annually at current harvesting rates and prices to forest landowners, loggers and sawmills.

### Annual Statewide Wood Products Loss

Annual Volume Harvested (bdft)	42,642,000 <sup>5</sup>	Sawlogs (subtracted bur oak)
Estimated Economic value to Landowners	\$ 8,528,517	Assuming \$0.2/ bdft revenue
Estimated Economic Value to Sawmills	\$ 8,528,517	Assuming \$0.2/ bdft revenue
Estimated Economic Value to Manufacturers	\$ 8,528,517	Assuming \$0.2/ bdft revenue
Indirect Economic Impact	\$ 5,628,822	1.223 based on IMPLAN 2008
<b>Total Economic Impact</b>	<b>\$ 31,214,373</b>	

Based on 2011 estimates, Iowa had 4.8 billion board feet of merchantable size trees that are the most preferred by gypsy moth for food within Iowa's 3 million acres of forest. The potential loss of income of this readily available resource to Iowa forest landowners is summarized in the table on the following page. This is the estimated timber value of the most preferred gypsy moth forest resource that exists today in Iowa's forests.

### Statewide Landowner Value

Volume Available to be Harvested (bdft)	3,712,680,562 <sup>6</sup>	Sawlogs
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<sup>4</sup> <[www.fs.fed.us/ne/morgantown/4557/gmoth/gtr/tab2.html](http://www.fs.fed.us/ne/morgantown/4557/gmoth/gtr/tab2.html)> December 13, 2012.

<sup>5</sup>Miles, P.D. Forest Inventory EVALIDator web-application version 4.01 beta. St.Paul, MN:U.S. Department of Agriculture, Forest Service, Northern Research Station. December 13, 2012. <http://fiatools.fs.fed.us/Evalidator4/tmattribute.jsp>

<sup>6</sup>Miles, P.D. Forest Inventory EVALIDator web-application version 4.01 beta. St.Paul, MN:U.S. Department of Agriculture, Forest Service, Northern Research Station. December 13, 2012. <http://fiatools.fs.fed.us/Evalidator4/tmattribute.jsp>

Estimated Existing Economic value to Landowners	<b>\$742,536,112</b>	Assuming \$0.2/ bdft profit
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Gypsy moth defoliates not only woodland trees but valuable park and ornamental trees. In urban situations, gypsy moth caterpillars are a significant nuisance during May, June, July as they crawl over homes, vehicles, outdoor furniture, and lawns leaving waste from their feeding. With tree canopy in Iowa communities averaging 12%, keeping urban trees healthy is important. Losses from affected urban trees include the cost of removing the tree, its “landscape value” and the cost of replacing that tree. Landscape value is a catch-all term that includes everything from a tree’s aesthetic value to its impact on property values, pollution removed from the environment and utility costs. Losses from affected urban trees are not annual, but rather a one-time phenomena, although spread out over many years. These numbers assume residential trees on private property represent the same percentages for preferred gypsy moth host trees as is being documented during street tree inventories. Community street tree inventories do not take into account these trees occurring in city parks and other urban areas or on private residential areas. Communities and homeowners will bear the cost burden of removing dead trees caused by gypsy moth defoliation.

#### Statewide Urban Tree Loss

Number of Trees <sup>7</sup>	5,500,000	Based on 26 million street trees
Removal Costs <sup>8</sup>	\$ 2,750,000,000	\$500/ tree
Replacement Costs	\$825,000,000	\$150/ tree
Landscape Value <sup>9</sup>	\$ 550,000,000	\$100/ tree annually
<b>Total Economic Impact</b>	<b>\$ 4,125,000,000</b>	

To determine the total economic impact to the wood products industry, annual industry losses are calculated in the table below using existing harvesting rates for tree species preferred by gypsy moth. Assuming gypsy moth takes 20 years to infect every preferred tree species in Iowa, we can estimate losses by determining the net present value (NPV) of each year’s impact. NPV translates future dollars into today’s dollars, using a discount rate. One way of thinking about NPV is to imagine paying for future losses by putting some money in the bank today. For example, putting \$100 in the bank today at a 4% interest rate could pay for \$104 in damages next year.

<sup>7</sup> Iowa community Forestry Tree Inventories, 23 communities, average number of street trees.

<sup>8</sup> Average removal and stump grinding costs, communication with Iowa arboriculture industry.

<sup>9</sup> Estimated using i-Tree STRATUM Analysis



**Present Value Calculation of preferred tree species as a result of gypsy moth defoliation over the next 20 years in Woodlands; assuming 4% discount rate and indirect impact rate of 22%.**

Year	Wood Products Industry (Future Dollars)	Present Value (2011 Dollars)
2011	\$1,560,720	\$ 1,500,690
2012	\$ 3,121,437	\$ 2,885,943
2013	\$ 4,682,157	\$ 4,162,419
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2028	\$ 29,653,653	\$ 14,074,881,
2029	\$ 31,214,370	\$ 14,245,833
Total (during spread)		\$ 195,331,752
Years 2030 on (Total)	\$ 31,214,370	\$ 356,145,792
<b>Total Present Value of the loss</b>		<b>\$ 551,477,544</b>
Discount Rate		4%
<b>Total Annualized Value of the Loss</b>		<b>\$ 22,059,102</b>

## Conclusion

Under these assumptions, the total impact of Gypsy Moth to Iowa's wood products businesses is over **\$551 million** or an annualized loss of over **\$22 million** in 2011 dollars for now into perpetuity for Iowa's economy. The result changes with the discount rate (for example, the total present value of losses go up if the discount rate goes down to the current Federal Funds rate target of 0.25%). Additionally, other economic losses would include non-timber products like nut production, reduced wildlife habitat and a **\$4.1 billion** loss of services from community trees. Job losses associated with this economic impact were not calculated because of access restrictions to that data. If Iowa can slow the spread, or find a solution to stop the spread of Gypsy Moth— losses to homeowners, wildlife, forest landowners and the wood products industry can be mitigated.

If you have potential Gypsy Moth egg masses, please contact Tivon Feeley at [tivon.feeley@dnr.iowa.gov](mailto:tivon.feeley@dnr.iowa.gov) or 515-281-4915 for instructions or questions. A photograph may help diagnosis.

## References

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